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STANDARD FOR

OPTICAL FIBER
DROP CABLE

Publication # ICEA S-110-717-2003

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(Adopted by TIA as ANSI/TIA-472F000, September 2004)

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Insulated Cable Engineers Association, Inc

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INSULATED CABLE ENGINEERS ASSOCIATION, Inc.

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**ICEA STANDARD
FOR
OPTICAL FIBER DROP CABLE**

PART 1

INTRODUCTION

1.1 Scope

1.1.1 General

This Standard covers optical fiber communications cables intended for use in outdoor and indoor/outdoor optical fiber drop applications. Materials, construction, and performance requirements are included in this Standard, together with applicable test procedures. Refer to ICEA S-104-696 for optical fiber communications cables intended for use in other combined indoor/outdoor applications, and to ICEA S-87-640 for optical fiber communication cables intended for use in other outdoor applications. Refer to ICEA S-83-596 for optical fiber communications cables intended only for indoor use.

1.1.2 Applications Space

Products covered by this Standard are intended for operation under conditions normally encountered in the last portion of all-optical networks. This space exists from the Network Access Point (NAP), or other hardware serving that purpose, ending at or inside the subscriber premises. These products convey communications signals (voice, video, and data) between the communications network and the subscriber premises. Products covered by this Standard may be factory-terminated with connectors or other telecommunications hardware as appropriate.

For the purposes of this Standard, user premises are defined as residential properties and small to medium sized businesses located in facilities that can be served by an optical cable having 12 or fewer fibers, with typical distances less than or equal to 100 m (300 ft) in length. Most applications will only require cables with four or fewer fibers. Products covered by this Standard are not intended for use in extended distance applications, which are typically characterized by higher fiber count cables and which specify more stringent design and performance requirements. The suitability of products covered by this Standard in applications other than those for which they are intended should be as agreed upon between the manufacturer and user.

1.1.3 Temperature Ranges

The normal temperature ranges for cables covered by this Standard are given in Table 1-1.

Table 1-1
Cable Normal Temperature Ranges

	Outdoor Cable		Indoor/Outdoor Cable (fire-resistant)	
	°C	°F	°C	°F
Operation	-40 to +70	(-40 to +158)	-40 to +70	(-40 to +158)
Storage and Shipping	-40 to +70	(-40 to +158)	-40 to +70	(-40 to +158)
Installation	-30 to +60	(-22 to +140)	-10 to +60	(+14 to +140)

1.1.4 Tensile Rating

For the purposes of this document, the standard tensile rating represents the maximum allowable installation load for the cable. The standard tensile ratings for products covered by this Standard are 1335 N (300 lbf) for cables designed for installation by pulling, and 440 N (100 lbf) for cables that are direct-buried, placed in the ground by trenching equipment, or blown into ducts. The residual load is defined as a load equivalent to 30 % of the standard tensile rating, as related to all cable designs except aerial self-supporting.

For self-supporting aerial applications there may be additional considerations, based on the particular application, which need to be addressed to ensure that the cable design is appropriate for the self-supporting distance (typically 30 m [100 ft] or less) and environmental loading requirements. See Paragraph 7.24 and Annex C for information on aerial plant requirements and considerations.

For aerial applications in which the drop cable is lashed to a separate messenger wire, the use of a cable designed for installation by direct burial, trenching, or pulling into duct may be adequate.

1.1.5 Minimum Bend Diameter

The standard minimum bend diameters for cables covered by this Standard are:

<u>Condition</u>	<u>Bend Diameter</u>
Unloaded (Installed):	20 x Cable OD
Loaded (During Installation):	40 x Cable OD

For cables not having a circular cross-section, bend diameter requirements are to be determined using the thickness (minor axis) as the cable diameter and bending in the direction of the preferential bend.

1.1.6 Fire-Resistance

Fire tests may be applicable based on the specific drop cable application. Users of this document are encouraged to consult pertinent Building and Fire Codes, such as those described in Paragraph 1.9, to ensure product compliance to the requirements for a particular installation.

For purposes of this document, cables intended strictly for outdoor use need not be listed for fire-resistance. Cables intended for indoor use, or which transition from outdoor to indoor, may be required to be tested and marked with the appropriate fire-resistance listing as referenced in Paragraph 1.9.

The choice of materials needed to achieve adequate fire-resistance may impact the ability of such cables to be handled at low temperatures. Refer to Table 1-1 for temperature ranges.

1.2 General

This publication is arranged such that cables may be selected from numerous constructions covering a broad range of installation and service conditions.

Parts 2 and 3 designate the materials, material characteristics, dimensions, and tests applicable to the particular component.

Part 4 covers assembly, cabling, and identification of individual optical fibers.

Part 5 includes cable coverings.

Part 6 provides other pertinent requirements not otherwise addressed by Parts 1 through 5, or by Parts 7 and 8 of this Standard.

Part 7 describes the test methods and performance requirements applicable to the component materials, in addition to Parts 2 & 3, and completed cables manufactured per this Standard. If there is a conflict between Parts 1 through 6 and Part 7, the provisions of Part 7 apply.

Part 8 contains routinely specified optical performance test methods and requirements for finished cables.

Part 9 contains cross-references to other standards and publications.

Annex A (Informative) contains information for users on ordering the types of cable products covered by this Standard.

Annex B (Informative) contains information on multimode fiber restricted modal launch (RML) performance.

Annex C (Informative) contains information on additional considerations for aerial drop cable installations.

Annex D (Informative) contains information on the fusing coordination test method for composite drop cables.

Annex E (Informative) contains information on other ICEA Standards not referenced elsewhere in this document.

1.3 Units

In this Standard metric (SI) units are used. Their approximate U.S. customary units are included where appropriate. Where approximate equivalents in alternate systems are included they are provided for information only and in most cases are rounded off for measurement convenience. Unless otherwise specified, the Rounding Method of ASTM E 29 shall be used. Rounding of U.S. customary units may be adjusted for measurement convenience. ICEA P-57-653 is a useful guide for metric units used in this publication.

1.4 Definitions

1.4.1 Cable Classification

In this Standard, communications cables are classified as one of the following types:

1.4.1.1 Composite Cables

Cables having both optical fibers and metallic conductors for the purposes of voice, video, or data transmission.

1.4.1.2 Dielectric Cables

Cables containing no metallic members or other electrically conductive materials.

1.4.1.3 Hybrid Cables

Cables which contain more than one type of optical fiber.

1.4.1.4 Indoor-Outdoor Cables

Cables that are listed for fire-resistance performance in accordance with one or more of the Codes listed in Paragraph 1.9, and which also meet the appropriate mechanical and environmental performance requirements for use outdoors, as defined elsewhere in this Standard. These cables are primarily used in applications that require a transition from the outside plant to indoors without a transition splice point. Some Codes allow for the passage of non fire-resistant cables from outdoors to indoors, but place additional restrictions on their use in such applications.

1.4.1.5 Metallic Cables

Cables that contain conductive members, including those not normally used to transmit information (voice, video, or data), such as metallic strength members, shields, or armors.

1.4.2 Network Access Point (NAP)

The point at which optical drop cables connect to the distribution network via splicing or the use of optical connectors. NAPs are characterized by closures supporting up to twelve subscriber drop connections and may include optical splitters.

1.4.3 Jackets and Sheaths

In this Standard, the term "jacket" refers to a continuous non-metallic covering, while "sheath" refers either to a continuous metallic covering or to a combination of jacket(s), together with metallic covering(s), strength member(s), or other components.

1.4.4 Optical Fiber and Electric/Electronic Terms

Refer to TIA/EIA-440 and to IEEE-812 for definitions of other optical fiber terms. Refer to ANSI/IEEE Standard 100 for definitions of other electrical and electronic terms.

1.4.5 Detail Specification

The term "Detail Specification" shall be used to refer to any requirement or set of requirements that are specific to the user's purchase. In case of conflict between a requirement called out in a Detail Specification and this Standard, the requirements of this Standard may be modified by agreement between the manufacturer and user. This definition does not apply to the optical fiber Detail Specifications referenced in Tables 2-1 and 2-2 of this Standard.

1.5 References

All documents referenced herein are listed in Part 9.

1.6 Information to Be Supplied by the User

When requesting proposals from cable manufacturers, the prospective user should describe the cable by referencing the pertinent Paragraphs of this Standard. To help avoid misunderstandings and possible misapplication of cable, the user should also provide relevant information concerning the intended application. Recommended ordering information is summarized in Annex A.

1.7 Modification of this Standard

Any requirement of this Standard may be modified by agreement between the manufacturer and user, but such modifications shall be clearly denoted as exceptions to this Standard. In this Standard, requirements which are recognized to have various options, but for which preferred values are given, have been introduced by phrases such as, "Unless otherwise specified," or "Unless otherwise modified by manufacturer and

user." Requirements not specified in this Standard, and which therefore must be determined in each case, are introduced by phrases such as ". . . established by agreement between manufacturer and user," or "as mutually agreed upon."

1.8 Quality Assurance

It is the responsibility of the manufacturer to establish a quality assurance system consistent with ANSI/ASQ Q9001, ISO 9001, TL 9000, or an alternate system acceptable to the user, which will assure conformance with the requirements of this Standard. When the user wishes to require a specific quality assurance program or special testing procedures, agreement between the user and the manufacturer should be reached before the order is placed.

1.9 Fire Resistance Codes

The fire-resistance requirements of optical fiber cable are addressed by the following Codes and are dependent upon the application for which it is being used and local jurisdictional requirements. Users are encouraged to contact the Local Authority Having Jurisdiction in order to determine the minimum fire-resistance requirements for a particular application, prior to placing an order.

United States Fire Resistance Codes:

1. NFPA 70, National Electrical Code (NEC)
2. Local Codes

Canada Fire Resistance Codes:

1. C22.2 No. 232, Canadian Standards Association (CSA)
2. Local Codes

Mexico Fire Resistance Codes:

1. Telecommunications - Cables - Optical Fiber Cables for Premises Applications (NMX-J-237-1997-NYCE)
2. Local Codes

1.10 Safety Considerations

Materials in the cable shall present no dermal or environmental hazards as defined by current industry Standards, or applicable federal or state laws and regulations. The manufacturer and user of cables made in accordance with this Standard are cautioned to observe any applicable health or safety rules and regulations relative to their manufacture and use. This Standard hereafter assumes that the manufacture, testing, installation, and maintenance of cables, defined herein, will be performed only by properly trained personnel, using suitable equipment, employing appropriate safety precautions, and working in accordance with applicable local, state and national safety requirements.

PART 2

OPTICAL FIBERS

2.1 General

The optical fiber used in the cable shall comply with the requirements set forth in the latest issue of TIA/EIA-4920000, Generic Specification for Optical Waveguide Fibers, and as required in the following paragraphs.

2.2 Optical Fiber Classes

Optical fibers used shall be of a type as listed in Tables 2-1 for multimode fibers, and 2-2 for single-mode fibers.

2.3 Optical Fiber Requirements

2.3.1 Unless otherwise specified, optical fibers shall conform to the requirements of Table 2-1 for multimode fibers, and Table 2-2 for single-mode fibers.

2.3.2 Each optical fiber shall be continuous throughout its length such that the requirements of Parts 7 and 8 of this Standard are met.

2.3.3 Unless otherwise specified, splices made on optical fibers during the fiber or cable manufacturing processes shall conform to the requirements of the latest issue of TIA/EIA-4920000.

2.3.4 Unless otherwise specified, any section of an optical fiber and its coating, including any section containing a factory splice, shall meet the same dimensional, mechanical, optical, and environmental requirements as un-spliced fiber, and shall be capable of meeting the performance requirements of Parts 7 and 8.

2.4 Optical Fiber Coating and Requirements

2.4.1 Optical fibers (glass core and glass cladding) shall be coated with a suitable material to preserve the intrinsic strength of the glass. Such coated fibers are termed "Primary Coated Fibers."

2.4.2 The thickness of the coating(s) shall be such that the applicable requirements of this Standard are met. The coating diameter for standard fibers is $250 \pm 15 \mu\text{m}$; other coating diameters are acceptable provided that all other applicable requirements are met. Dimensions shall be measured according to the methods of Paragraph 7.10.

2.4.3 Coating materials used shall meet the requirements of Part 7 of this Standard, or as otherwise permitted by the user.

2.4.4 The coating(s) shall be uniform and concentric with the glass. Coating(s) shall be removable by mechanical means without damage to the fiber(s) by using the manufacturer's recommended procedures. The strip force of the optical fiber's protective coating shall be measured according to FOTP-178. The force required to remove 30 ± 3 mm of the fiber's protective coating shall be between 1.0 N and 9.0 N

Table 2-1
Optical Fiber Specification Requirements - Multimode Fiber

Fiber Type	TIA/EIA Specification Reference		
	Sectional	Blank Detail	Detail
50 μm	492A000	492AA00	492AAAB
50 μm ⁽¹⁾	492A000	492AA00	492AAAC
62.5 μm	492A000	492AA00	492AAAA

Note (1): 850 nm laser-optimized 50 μm fiber.

Table 2-2
Optical Fiber Specification Requirements - Single-Mode Fiber

Fiber Class and Subclass	Fiber Type	TIA/EIA Specification Reference		
		Sectional	Blank Detail	Detail
IVa	Dispersion-Unshifted	492C000	492CA00	492CAAA
IVa	Dispersion-Unshifted with Low Water Peak	492C000	492CA00	492CAAB

PART 3

OPTICAL FIBER CORE UNITS

3.1 General

This Part defines specific types of units that may be used in outdoor and indoor/outdoor optical fiber drop cables, such as: loose buffer tubes, optical fiber ribbons, and tight buffered fibers. Fiber units are not limited to these types. Other types of units may be used provided that they meet the intent of Parts 3 and 4.

3.2 Loose Buffer Tubes

Loose buffer tubes consist of optical fiber(s) or optical fiber ribbon(s) inside a tube that isolates the fibers from outside stresses. The inside dimension is greater than the maximum dimension of the combined optical elements surrounded by the tube. The space between the optical elements and the inside of the tube contains a suitable water blocking material.

3.2.1 Loose Buffer Tube Dimensions

Buffer tube dimensions are set by the manufacturer to ensure that the applicable performance requirements of this Standard are met. Dimensions shall be measured according to the methods of Paragraph 7.10.

3.2.2 Loose Buffer Tube Requirements

3.2.2.1 The loose buffer tubes shall be constructed such that the finished cable meets all applicable performance requirements specified in Part 7.

3.2.2.2 The loose buffer tubes shall be uniform and concentric. Buffer tubes must be removable, without damage to the fibers, using the manufacturer's recommended procedures.

3.2.2.3 Each loose buffer tube shall be uniquely identifiable. Methods shall conform to Paragraph 4.3.

3.3 Optical Fiber Ribbons

A ribbon is a planar array of optical fibers.

3.3.1 Ribbon Identification

Each ribbon shall be uniquely identifiable. Methods shall conform to Paragraph 4.3. Ribbons may contain more than one unit, in which case separate units shall be appropriately identified.

3.3.2 Fiber Identification in Ribbons

Each fiber within a ribbon shall be uniquely identifiable. Methods shall conform to Paragraphs 4.2 and 4.3, as applicable.

3.3.3 Ribbon Fiber Counts

The following are common fiber counts of optical fiber ribbons that may be used in the applications covered by this Standard: 2, 4, 6, 8, and 12. Fiber counts in ribbons shall be established by agreement between manufacturer and user.

3.3.4 Ribbon Requirements

Ribbons shall be constructed so that the finished cable meets all applicable performance requirements specified in Part 7. The following additional requirements pertain specifically to ribbons:

3.3.4.1 Ribbon Dimensions

Certain ribbon dimensions may be important in cable design, in splice apparatus, or for successful splicing of one ribbon to another. All measurements, except the outer matrix dimensions, shall be referenced from either the cladding edge or the center of the core. Fiber coatings shall not be used for reference. Important dimensions are shown in Figure 7-1 and Table 7-1. Measure the attributes as established by agreement between manufacturer and user, and as directed by Paragraph 7.11.

3.3.4.2 Ribbon Separability Test

Test for ribbon separability per Paragraph 7.12.

3.3.4.3 Ribbon Twist Test

Test ribbons for robustness per Paragraph 7.13.

3.3.4.4 Ribbon Residual Twist Test

Measure the ribbon residual twist according to Paragraph 7.14.

3.3.4.5 Fiber Crossovers in Ribbons

The fibers shall be parallel and shall not cross over throughout the length of the ribbon.

3.3.4.6 Ribbon Strippability

At least 25 mm (1.0 in) of the matrix and the fibers' protective coatings shall be removable with commercially available stripping tools from aged or unaged ribbons. There shall be no fiber breakage. Any remaining coating residue shall be readily removable using isopropyl alcohol wipes. Aging requirements are addressed in Paragraph 7.16 (See Paragraph 7.16.2.1).

3.4 Tight Buffer

A tight buffer consists of one or more layers of buffer material applied around the individual optical fiber, so that it is in contact with the coating of the optical fiber.

3.4.1 Tight Buffer Dimensions

Buffer dimensions are established by the cable manufacturer to ensure that the applicable performance requirements of this Standard are met. Dimensions shall be measured according to the methods of Paragraph 7.10.

3.4.2 Tight Buffer Requirements

3.4.2.1 The tight buffer shall be constructed so that the finished cable meets all applicable performance requirements specified in Part 7.

3.4.2.2 The tight buffer shall be uniform and concentric. It must be removable, without damage to the fibers, using the manufacturer's recommended procedures.

3.4.2.3 Each tight buffered fiber shall be uniquely identifiable. Methods shall conform to Paragraph 4.2.

3.4.2.4 The tight buffered fiber shall be strippable in accordance with Paragraph 7.15.

PART 4

CABLE ASSEMBLY, FILLERS, STRENGTH MEMBERS, AND FIBER AND UNIT IDENTIFICATION

4.1 Cabling of Multi-Fiber Optical Fiber Cables

Multiple fiber communications cables shall be assembled in accordance with this Part.

4.2 Identification of Fibers within a Unit

4.2.1 In units with multiple fibers, each fiber in the unit shall be readily identifiable. Identification shall be provided by means of color coding, by positional configuration, or by other means as mutually agreed upon between manufacturer and user.

4.2.2 For color-coding, the color order and color definitions designated for identification of individual fibers shall be in accordance with TIA/EIA-598, "Optical Fiber Cable Color Coding." (The order for the first 12 standard positions, per TIA/EIA-598, is listed for convenience in Table 4-1.)

4.3 Identification of Units within a Cable

4.3.1 In cables with multiple units, each unit shall be readily identifiable. Identification shall be provided by means of color coding, printed legends, bar codes, positional configuration, tapes, threads, or by other means as mutually agreed upon.

4.3.2 For color coding, the color order and color definitions designated for identification of individual units within a cable shall be in accordance with TIA/EIA-598, "Optical Fiber Cable Color Coding." (The order for the first 12 standard positions, per TIA/EIA-598, is listed for convenience in Table 4-1.)

4.4 Strength Members

Central or non-central strength members, or both, may be included in the cable design. These members may be metallic, or non-metallic, or both. Strength members shall provide sufficient tensile strength for installation and residual rated loads to meet the applicable performance requirements of Part 7.

Table 4-1
Individual Fiber, Unit and Group Identification

Position # ⁽¹⁾	Base Color per TIA/EIA	Abbreviation/ Print Legend
1	Blue	1 or BL or 1-BL
2	Orange	2 or OR or 2-OR
3	Green	3 or GR or 3-GR
4	Brown	4 or BR or 4-BR
5	Slate	5 or SL or 5-SL
6	White	6 or WH or 6-WH
7	Red	7 or RD or 7-RD
8	Black	8 or BK or 8-BK
9	Yellow	9 or YL or 9-YL
10	Violet	10 or VI or 10-VI
11	Rose	11 or RS or 11-RS
12	Aqua	12 or AQ or 12-AQ

Note (1): Only the first 12 fiber colors from TIA-598 are listed, as the cables covered by this Standard are intended only for applications requiring cables with 12 or fewer fibers.

4.5 Assembly of Cables

4.5.1 The required number of optical fibers and metallic conductors shall be assembled into layers as a concentric type, or into units as a unit-type construction, or into other suitable constructions such as flat ribbon or slotted core configurations.

4.5.2 When tapes or threads are used as unit identifiers, their colors shall conform to the requirements of TIA/EIA-598. The lay length of identifiers, when used, is not specified, but the length shall assure adequate segregation and identification of the cable components enclosed.

4.5.3 Other components may be used as appropriate for specialized needs. For example, cable fillers may be used to occupy the interstices between cable elements. An inner jacket may be applied for protection or other purposes.

4.6 Filling and Flooding Materials

4.6.1 Filling material may be used in the buffer tube to block the ingress and axial migration of water through the cable core. Tapes or other materials may be used which meet the intent of this paragraph and the requirements of Part 7.

4.6.2 Flooding material may be used in the cable core or sheath interface(s) for the purpose of preventing the ingress and migration of water. Tapes or other materials may be used which meet the intent of this paragraph and the requirements of Part 7.

4.6.3 The filling and flooding materials shall be compatible with all components of the cable that they contact. The elements typically in contact with the filling material are optical fibers, tight buffered fibers, optical fiber ribbons, and buffer tubes. The elements typically in contact with the flooding compound are buffer tubes, strength members, metal tapes, and jackets. Refer to Paragraph 7.16 for methods to test material compatibility.

PART 5

COVERINGS

5.1 Binders

If required for manufacturing reasons, a binder may be applied over the core, metallic shield(s), or armor(s). Binders may also be used for unit or multi-unit identifiers as specified in Paragraph 4.5.2.

5.2 Shielding, Armoring, or Other Metallic Coverings

5.2.1 General

If shielding, armoring, or other metallic covering is required for a specific construction, requirements shall be established by agreement between manufacturer and user. A shielding or armoring system may consist of single-tape or dual-tape constructions.

For the purpose of this Standard, in dual-tape constructions the term "shielding-tape" shall refer to a tape containing a highly conductive metal, such as copper or aluminum, which is present in the cable primarily for its electrical properties. In addition to tape, shielding may also consist of a serving, wrap, or braid of wires of various metals and gauges. The term "armoring tape" shall refer to a tape containing lower conductivity metal, such as steel or stainless steel, which is present in the cable primarily for mechanical protection of the cable core. Care should be used when putting dissimilar metals into electrical contact with each other. Coatings, claddings, or other methods of protection may be necessary to prevent galvanic interaction.

Shielding may be applied to a cable for any of several reasons including, but not limited to: lightning protection, bonding and grounding considerations, and electrical shielding.

Armoring may be applied to a cable for any of several reasons including, but not limited to: rodent resistance, termite resistance, environmental protection, and general mechanical protection.

5.2.1.1 Rodent Resistance

There is currently no test Standard for evaluating the rodent resistance of optical fiber cable. Prospective users should contact the cable manufacturer for information relative to the rodent resistance of their cable product.

5.2.1.2 Lightning Resistance

The Lightning Damage Susceptibility Test is described in FOTP-181. This test is not required for optical drop cables, but may be utilized for products covered by this

Standard as agreed upon between manufacturer and user. This test, when specified, applies only to cables with metallic components.

5.2.1.3 Shield Heating Test

The Shield Heating Susceptibility Test is described in Paragraph 7.31. This test may be applicable for optical drop cables used in certain applications, as specified by the Local Authority Having Jurisdiction, or may be utilized for products covered by this Standard as agreed upon between manufacturer and user. This test, when specified, applies only to cables with metallic shielding, armoring, or other metallic coverings.

5.2.2 Metallic Covering Materials

Finished cable utilizing tape shielding, armoring, or other metallic covering material shall meet the completed cable requirements of this Standard. These metallic covering materials shall be electrically continuous throughout the cable. Refer to Paragraph 7.4.2 for test methods.

Tape materials and conductivity are not specified.

5.2.3 Metallic Covering Fabrication

5.2.3.1 Shield and Armor Application

The cable shield and/or armoring tape(s), if present, shall be applied over the core for a single jacketed construction, or over the inner jacket for a double-jacketed construction. Additional applications of jacket and armor may be applied as required. The shield and/or armor may be either flat or corrugated.

When a dual-tape construction is specified by the Detail Specification, in which both shielding and armoring tapes are to be used, the armoring tape shall be applied directly over the shielding tape unless otherwise specified in the Detail Specification.

5.2.3.2 Shield and Armor Overlap

When a dual-tape shielding and armoring construction is provided, the edges of the inner shielding tape may overlap, but any overlap shall not be coincidental with the overlap of the outer armor tape. If the inner shield tape does not overlap, the gap between the edges of the formed shield tape shall not exceed 5 mm (0.2 in) plus 4 % of the total circumference as measured over the core, or over the inner jacket.

All single tape shields or armors applied over cores (or over inner jackets for double jacketed cables), and all outer armor tapes applied over an inner-shield tape, shall have an overlapping edge. Alternatively, armors may have welded edge joints. Such constructions shall meet the intent of this Standard, and shall have requirements as agreed upon between manufacturer and user.

5.2.3.3 Splicing of Armor or Shield

The breaking strength of any section of armor or shield containing a splice shall not be less than 80 % of the breaking strength of an adjacent non-spliced section of tape.

For shielding tapes, a 1 m (3 ft) section of tape containing a splice shall have a resistance not greater than 110 % of the resistance of an adjacent section of shield of equal length and width.

Splices in tapes shall be electrically continuous. When plastic-coated tapes are to be joined, the coating may be removed prior to making the splice.

5.3 Jackets

The types of jacket materials for the cable designs covered by this Standard are not specified. For indoor/outdoor applications, or other applications requiring some measure of fire-resistance, cable materials shall be selected to ensure compliance with the applicable Fire Resistance Codes, such as those listed in Paragraph 1.9.

5.3.1 Outer Jacket

All outer jackets for optical fiber cables shall meet the mechanical and environmental requirements as specified in the following Paragraphs, and in Paragraphs 7.6 (Environmental Stress Cracking Resistance Test), 7.7 (Jacket Shrinkage Test), and 7.8 (Weathering Test) of this Standard.

Outer jackets shall be smooth, free from holes and other defects, and shall not adhere to underlying optical fibers, tight buffered optical fibers, buffer tubes, or to sub-unit jackets, as applicable. See also Paragraph 5.5 for jacket repairs.

The thickness of the outer jacket is not specified in this Standard. For fire-resistant drop cables, the jacket thickness shall comply with the applicable fire-resistance listing requirements.

5.3.2 Inner Jacket(s)

Inner jackets are not required, but may be incorporated into drop cable designs to cover cable cores, or sub-units within the core, or both, when agreed upon between the manufacturer and user.

5.4 Other Coverings

Other coverings (e.g., tape wraps and braids in metallic, non-metallic, or both forms) may be used.

5.5 Jacket Repairs

Jackets may be repaired using good commercial practice and in accordance with fire-resistance listing requirements, when applicable, utilizing the same material as the original cable jacket. Cables with repaired jackets must be capable of meeting all applicable requirements of this Standard.

5.6 Ripcords

Ripcords may be included at the discretion of the manufacturer or as requested by the user. When used, ripcords must perform in a reliable and functional manner.

PART 6

OTHER REQUIREMENTS

6.1 Identification and Date Marking

Each length of fiber optic cable shall be permanently identified as to fire-resistance rating (if applicable), manufacturer, and year of manufacture using one or more of the following methods:

6.1.1 The marking shall be indented or surface printed on the outer jacket. The characters shall be spaced at intervals not exceeding 24 in (610 mm) for products marked in feet, or not exceeding 1 m (40 in) for products marked in metric units. The marking method used shall produce a clear, distinguishable, and contrasting marking.

6.1.2 When surface or indent marking is not practicable or desirable, a marking tape under a transparent or translucent jacket may be used. Markings on the tape shall be spaced at intervals not exceeding 24 in (610 mm) for products marked in feet, or not exceeding 1 m (40 in) for products marked in metric units.

6.1.3 Manufacturer and year of manufacture marking may be provided by including marker threads or tapes in the cable constructions as follows:

6.1.3.1 The manufacturer's identification shall be by marker thread combinations assigned by the relevant Nationally Recognized Testing Laboratory.

6.1.3.2 When used, year of manufacture marker threads or tapes shall identify the last digit of the year as indicated in Table 6-1.

6.1.3.3 When used, manufacturer and/or year markers shall have no adverse effects on the optical characteristics of the cable.

6.1.4 When a core covering is present, marking, if used, shall be spaced at intervals not exceeding 24 in (610 mm) for products marked in feet, or not exceeding 1 m (40 in) for products marked in metric units.

6.2 Optical Cable Identification and Other Markings

6.2.1 Unless otherwise specified, completed cable shall bear appropriate markings to indicate that it is an optical cable. Such marks shall be applied in accordance with Paragraphs 6.1.1 or 6.1.2. Manufacturer's trade names or other appropriate legends may be used to fulfill this requirement.

Table 6-1
Year of Manufacture Marker Threads

Year Ending In	Marker Color
1	Blue
2	Orange
3	Green
4	Brown
5	Slate
6	White
7	Red
8	Black
9	Yellow
0	Violet

6.2.2 Cable suitable for direct-buried applications shall be appropriately marked as required by Section 35 of the National Electrical Safety Code (NESC), ANSI C2. The appropriate identification symbol for communication cable (i.e. handset symbol) shall be printed on the outermost cable jacket.

6.2.3 Other appropriate markings (e.g., fire-resistance listing) shall be applied.

6.3 Length Marking

Each length of cable shall be continuously and sequentially numbered with length markings, using one or both of the methods given in Paragraphs 6.1.1 and 6.1.2. The accuracy of length marking by these methods shall be such that the actual length of any cable section is never less than the length indicated by the marking. Unless otherwise specified by agreement between the manufacturer and the user, the accuracy of cable length marking shall be verified by measuring a length of the cable using the method of Paragraph 7.9.

6.3.1 The marking shall be indented or surface printed on the outer jacket. The characters shall be spaced at intervals not exceeding 24 in (610 mm) for products marked in feet, or not exceeding 1 m (40 in) for products marked in metric units. The marking method used shall produce a clear, distinguishable, contrasting marking.

6.3.2 The numbers shall be legible and durable. An occasional illegible marking is permissible if there is a legible marking located not more than 2 m for cables marked in meters, or 4 ft for cables marked in feet, from the illegible mark.

6.3.3 The length markings shall not go through zero at any point.

6.4 Cable Remarking

Cables may be remarked in accordance with the following:

6.4.1 Defective markings may be removed, if allowed by the listing agency, and the cable remarked with the same color.

6.4.2 Alternatively, if allowed by the listing agency, the defective marking may remain and the cable may be re-marked using another contrasting color marking on a different portion of the circumference. This marking shall meet all of the original requirements. A tag shall be attached to both the outside of the cable and to the reel to indicate the correct printing.

6.5 Packaging and Marking

Completed fiber optic cable shall be packaged and marked as agreed upon by manufacturer and user. The following general provisions apply:

6.5.1 Cable may be in coils, wound on reels, or supplied in other suitable configurations.

6.5.2 Each package shall contain only one continuous length of cable.

6.5.3 Coils and other non-reeled packaging configurations may be individually wrapped in a protective wrapper or packed in a carton. Packs shall be so constructed that the cable in the wrap or in the carton is appropriately protected during shipment, storage and installation. The inner diameter of the coil shall be large enough to prevent damage to the cable during winding and unwinding.

6.5.4 When cable is shipped on reels or spools, the reels or spools shall be constructed to prevent damage to the cable during shipment, storage, and use.

6.5.4.1 The diameter of the reel or spool drum shall be large enough to prevent any damage to the cable during reeling or unreeling.

6.5.4.2 To protect cable on reels or spools from damage during shipment, suitable protection shall be applied and secured to the reels or spools.

6.5.4.3 The inner and outer ends of cable on spools or reels shall be securely fastened to prevent the cable from coming loose in transit. If on-reel testing is required, there shall be agreement between the manufacturer and user as to the length and configuration of the inner end.

6.5.5 Each outer pack (carton or wrap), or reel or spool flange, shall be appropriately marked with the manufacturer's identification, the year of manufacturer, the type of cable, the number and size of fibers and/or conductors, and the length of

cable contained therein. Other information, as required for listing purposes, or as agreed to by manufacturer and user, shall be included.

6.5.6 Each end of every length of cable may be appropriately sealed to prevent the entrance of moisture.

PART 7

TESTING AND TEST METHODS

7.1 Testing

All test methods described in Part 7 may not be applicable to each type of cable covered by this Standard. To determine which requirements apply, refer to the appropriate Paragraphs of Parts 4 through 6 and Part 8.

Fiber optic cables produced in accordance with this Standard shall be tested by the manufacturer to determine compliance with the requirements of this Standard. When there is a conflict between the test methods provided in Part 7 and the publications of other organizations to which reference is made, the methods provided in Part 7 shall apply.

7.2 Extent of Testing

All tests specified in Part 7 shall be performed in accordance with Paragraph 1.8.

7.3 Standard Test Conditions

7.3.1 Unless otherwise specified, testing shall be performed at the standard conditions defined in TIA/EIA-455, as follows:

<u>Condition</u>	<u>Standard Ambient</u>
Temperature	23 $\pm$ 5°C
Relative Humidity	20 to 70 %
Atmospheric Pressure	Site Ambient

7.3.2 Standard Optical Test Wavelengths

The standard optical test wavelengths for Part 7 are as follows, unless otherwise specified in the individual test:

<u>Fiber Type</u>	<u>Wavelength</u>
Single-mode	1550 nm
Multimode	1300 nm

Specified changes in optical performance include an allowance for measurement repeatability.

7.4 Testing of Conductive Wires in Composite Optical Drop Cables

7.4.1 Electrical Testing of Communications Conductors

When a composite cable is required, the applicable metallic conductor requirements shall be as established by agreement between the manufacturer and user. The requirements of ANSI/ICEA S-84-608 should be considered when determining appropriate requirements.

7.4.2 Fusing Coordination Test (Optional)

The Fusing Coordination Test is described in Annex D. This test may be applicable for composite optical drop cables used in certain applications, or may be utilized for products covered by this Standard as agreed upon between manufacturer and user. This test, when specified, applies only to cables with conductive wiring intended for current carrying applications.

7.4.3 Electrical Testing of Other Conductive Elements

Shields and armors of metallic cables, as described in Paragraph 5.2, shall be tested for continuity in accordance with the test requirements for Continuity of Other Metallic Elements, as contained in ASTM D 4566.

7.5 Verification of Physical Construction, Color Code, and Identification

Visual inspections shall be made to verify conformance to requirements for color coding of fibers, metallic conductors, fiber units, coverings, binders, identification markers, etc.

7.6 Environmental Stress Cracking Resistance Test

This test is limited to polyolefin-based jackets with an outside diameter of < 30 mm (1.2 in), utilizing a sample of a completed cable as the specimen.

7.6.1 Test Procedure

The test is performed on specimens of finished cable of a length sufficient to perform the test. Select a mandrel with a diameter less than or equal to 10X the cable diameter. Bend each cable specimen in an arc of approximately 180 degrees around the mandrel. Remove each bent specimen from the mandrel and fix the ends to hold it in the bent configuration. Immerse the bent portion of each specimen into the stress crack reagent. See ASTM D 1693-01 for guidance on stress crack reagents.

Keep the bent specimen in the reagent at a temperature of $50 \pm 2^{\circ}\text{C}$ for a period of 48 hours. At the end of the immersion period, remove the specimens from the reagent bath and examine the outer jacket of each specimen.

For cables not having a circular cross-section, bending requirements are to be determined using the thickness (minor axis) as the cable diameter and bending in the direction of the preferential bend.

7.6.2 Acceptance Criteria

The jackets shall show no cracks or splits.

7.7 Jacket Shrinkage Test

The jacket shrinkage test measures the shrinkage of a cable jacket specimen due to exposure to temperature conditioning for a specified period of time.

7.7.1 Test Procedure

Cable jacket shrinkage measurements and data reporting shall be as required by FOTP-86. Remove all other cable components (strength members, armors, etc.) from the jacket samples before testing.

The samples shall be conditioned for two hours at 110°C. Alternatively, if the material melting point is less than 110°C, condition for four hours at 85°C.

7.7.2 Acceptance Criteria

The jacket shrinkage shall not exceed 5 % when the jacket samples are tested in accordance with FOTP-86.

7.8 Weathering Test

The weathering test measures the ability of the jacket material to maintain its integrity when exposed to solar radiation for extended periods of time, such as those found in aerial installations.

This test applies only to non-polyethylene jacket materials, or polyethylene materials not meeting one or more of the following conditions:

<u>Parameter</u>	<u>Requirement</u>
Carbon black content	$2.6 \pm 0.25 \%$
Average particle size	$\leq 20 \text{ nm}$

In the case where a polyethylene jacket material meeting the above requirements is used, this test is not required. Otherwise the weatherability test must be performed as follows:

7.8.1 Test Procedure

The cable jacket shall be subjected to a light exposure test in accordance with ASTM G 155, Cycle 1, except that the exposure shall be for a minimum of 720 hours.

7.8.2 Acceptance Criteria

The jacket shall retain at least 80 % of its original elongation and tensile strength when tested in accordance with FOTP-89.

7.9 Verification of Cable Length and Marking Accuracy

7.9.1 Test Procedure

The length between printed length marks on a section of cable at least 3 meters (for cables marked in meters) or 10 feet (for cables marked in feet) in length shall be measured and compared with the length indicated by the printed markers. Calculate the difference between the actual measured length and the marker-indicated length (a measured length longer than the marker-indicated length is represented as a positive value), and divide this difference by the actual measured length to determine the percentage accuracy, plus or minus, of the marking.

7.9.2 Acceptance Criteria

The actual cable length shall be within 0 % to +1 % of the marked cable length.

7.10 Dimensions of Fibers, Tight Buffered Fibers, and Buffer Tubes

7.10.1 Test Procedures

Optical fiber measurements and data reporting shall be as required by FOTP-173.

Tight buffered fiber and buffer tube measurements and data reporting shall be conducted in accordance with FOTP-13 and using ASTM D 4565 for guidance on technique and calculations.

7.10.2 Acceptance Criteria

Optical fiber requirements are listed in Part 2. Buffer tube requirements are listed in Paragraph 3.2. Tight buffer requirements are listed in Paragraph 3.4.

7.11 Ribbon Dimensions

7.11.1 Test Procedures

Measure the agreed upon ribbon dimensions using FOTP-123. Any of the methods described in FOTP-123 may be used.

7.11.2 Acceptance Criteria

Important dimensions are shown in Figure 7-1. Ribbon dimensions shall not exceed those listed in Table 7-1.

Figure 7-1
Ribbon Dimensional Parameters

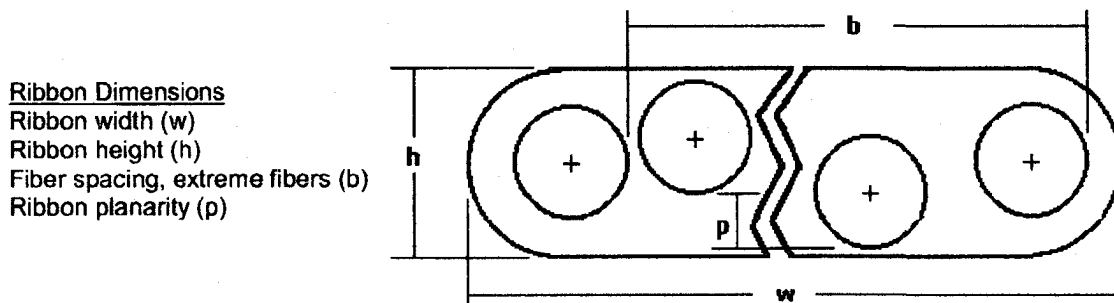


Table 7-1
Maximum Dimensions of Optical Fiber Ribbons (μm)

Number of Fibers (1)	Ribbon Width (w)	Ribbon Height (h)	Fiber Alignment	
			Extreme fibers (b)	Planarity (p)
4	1220	360	786	50
6	1648	360	1310	50
8	2172	360	1834	50
12	3220	360	2882	75

Note (1): Dimensions for ribbons with fiber counts not listed should be established between manufacturer and user.

7.12 Ribbon Separability Test

The ribbon separability test ensures the ability to separate fibers, or groups of fibers, from a ribbon.

7.12.1 Test Procedure

7.12.1.1 Obtain a ribbon fiber sample with a minimum length of 300 mm.

7.12.1.2 The test for separability is to be performed for the number of fibers to be separated from the ribbon in accordance with the Detail Specification.

7.12.1.3 A starting separation length of ≥ 50 mm is achieved with a knife, or other appropriate method, in accordance with Figure 7-2. Separation shall be accomplished without specialized tools or apparatus.

7.12.1.4 Each specimen is separated by hand as shown in Figure 7-3. The separation speed shall be approximately 500 mm/min.

7.12.2 Acceptance Criteria

Separation shall be readily accomplished by hand. After separation, there shall be no mechanical damage to the fibers and the color of the fibers shall still be discernible.

Figure 7-2
Ribbon Preparation

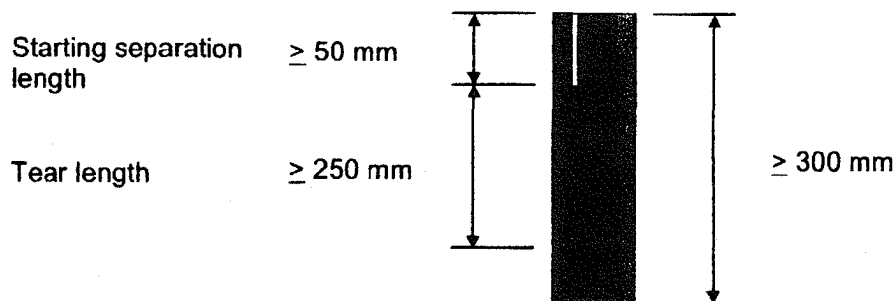
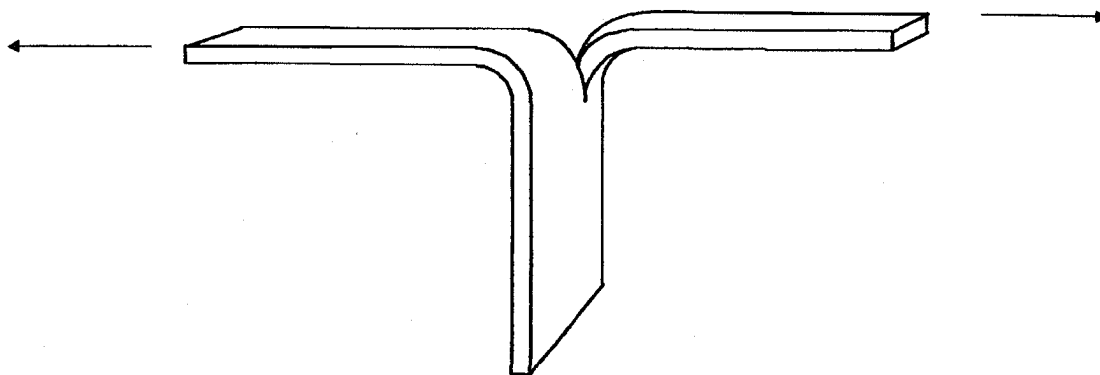


Figure 7-3
Ribbon Separation



7.13 Ribbon Twist Test

The ribbon twist test, or robustness test, evaluates the ability of the ribbon to resist splitting or other damage while undergoing dynamic twisting. The ribbon is cyclically twisted while under a specified load.

7.13.1 Test Procedure

7.13.1.1 Test ribbon robustness using FOTP-141.

7.13.1.2 The default test conditions of the FOTP apply and are as follows:

<u>Parameter</u>	<u>Requirement</u>
Minimum number of cycles:	20 @ 10 to 20 cycles per minute
Load:	500 $\pm$ 25 g
Rotation:	180 $\pm$ 10 degrees in each direction
Ribbon gauge length:	300 $\pm$ 10 mm

7.13.2 Acceptance Criteria

There shall be no separation of individual fibers from the ribbon sample.

7.14 Ribbon Residual Twist Test

The ribbon residual twist test, or flatness test, evaluates the degree of permanent twist in a cabled optical fiber ribbon.

7.14.1 Test Procedure

7.14.1.1 Test ribbon residual twist in accordance with FOTP-131.

7.14.1.2 The default test conditions of the FOTP apply and are as follows:

<u>Parameter</u>	<u>Requirement</u>
Ribbon gauge length:	50 $\pm$ 5 cm
Test load:	100 $\pm$ 5 g
Preconditioning requirements:	Age ribbon at 85 °C, uncontrolled relative humidity, for 30 days

7.14.2 Acceptance Criteria

There shall be no more than 8 degrees of residual twist per linear centimeter exhibited by the ribbon sample.

7.15 Tight Buffer Strippability Test

The tight buffer strippability test measures the force required to strip the buffer material and the fiber coating.

7.15.1 Test Procedure

FOTP-178 shall be used.

7.15.2 Acceptance Criteria

The force required to strip the buffer material and the fiber coating of a 15 ± 1.5 mm specimen, in a single operation, shall be between 1.3 N and 13.3 N.

7.16 Material Compatibility and Cable Aging Test

This test ensures compatibility between cable components (e.g., fibers, plastics, water blocking materials, metals, etc.)

7.16.1 Test Procedure

Sufficient lengths of completed cable shall be aged at 85°C, uncontrolled relative humidity, for 30 days. The cable ends shall be capped.

After aging, the components described in the Paragraphs below shall be removed from the cable and tested as described in the applicable Paragraphs.

7.16.2 Acceptance Criteria

7.16.2.1 Fiber Strippability

FOTP-178 shall be used for measuring the strip force needed to remove the optical fiber's protective coating or coating and buffer.

The coating of the fibers shall not show any signs of cracking, splitting, or delamination, when examined under 5X magnification. The force required to remove 30 ± 3 mm of the fiber's protective coating shall be between 1.0 N and 9.0 N.

For tight buffer fibers, the force required to strip the buffer material and the fiber coating of a 15 ± 1.5 mm specimen, in a single operation, shall be between 1.3 N and 13.3 N.

The strippability of optical fiber ribbons after aging shall meet the requirements of Paragraph 3.3.4.6.

7.16.2.2 Buffer Tube Bending Test

Select a mandrel having a diameter that is the larger of 75 mm (3 inches), or 20X the tube diameter.

Samples of the aged buffer tubes shall be wrapped three times (within 30 seconds) around the mandrel, removed, and then straightened. The buffer tube shall not show signs of splitting, cracking, or delamination under 5X magnification.

7.16.2.3 Jacket Tensile Strength and Elongation Test

The jacket shall retain a minimum of 60 % of its unaged tensile strength and elongation values. Jacket material tensile and elongation shall be tested in accordance with FOTP-89.

7.16.2.4 Delamination

Plastic coatings on metal tapes shall show no evidence of delamination.

7.17 Cable Low and High Temperature Bend Test

The low and high temperature bend test determines the ability of an optical fiber cable to withstand bending at low and high temperatures, as might be encountered during installation.

7.17.1 Test Procedure

Test in accordance with FOTP-37. The low temperature test shall be conducted at -30°C for outdoor cables and -10°C for indoor/outdoor cables. The high temperature test shall be conducted at 60°C for all cable types.

Test Method I or II of FOTP-37 may be used. The number of turns shall be four.

The mandrel diameter shall be the larger of 20X cable diameter or 150 mm.

For cables not having a circular cross-section, bending requirements are to be determined using the thickness (minor axis) as the cable diameter and bending in the direction of the preferential bend.

7.17.2 Acceptance Criteria

The presence of visible cracks, splits, tears, or other openings, on either the inner or outer surface of the jacket, constitutes a failure. None of the sheath components shall show visible cracking when removed successively and examined. For single-mode fibers, the increase in attenuation shall be ≤ 0.40 dB at 1550 nm. For multimode fibers, the increase in attenuation shall be ≤ 0.60 dB at 1300 nm.

7.18 Cable External Freezing Test

This test determines the ability of a cable to withstand the effects of freezing water (ice) that may immediately surround the optical fiber cable jacket by observing any changes in the physical appearance of the jacket, or in the measured cable optical attenuation.

7.18.1 Test Procedure

Cable freezing test measurements and data reporting shall be as required by FOTP-98, Method A, using the Temperature Exposure Procedure.

7.18.2 Acceptance Criteria

The presence of visible cracks or other openings on the outer surface of the jacket constitutes a failure. For single-mode fibers, the increase in attenuation shall be ≤ 0.40 dB at 1550 nm. For multimode fibers, the increase in attenuation shall be ≤ 0.60 dB at 1300 nm.

7.19 Cable Compound Flow (Drip) Test

The compound flow test measures the ability of the cable filling and flooding compounds to resist flowing at an elevated temperature. This test is applicable only to cables that contain filling and/or flooding compounds.

7.19.1 Test Procedure

Compound flow test measurements and data reporting shall be as required by FOTP-81, with preconditioning of specimens permitted. Testing shall be conducted at a temperature of 70 ± 2 °C for 24 hours.

7.19.2 Acceptance Criteria

There shall be ≤ 0.05 grams of material drip from the cable sample under test.

7.20 Cable Temperature Cycling Test

The cable temperature cycling test evaluates the performance of an optical fiber cable at the operational temperature extremes. Because the expansion coefficients and rigidity moduli of plastic coatings, buffers, armors, and strength members are different from those for the optical fibers themselves, bend effects that affect the optical performance of the cable can occur with temperature changes.

7.20.1 Test Procedure

Cable temperature cycling, measurements, and data reporting shall be as required by FOTP-3. The cable shall be tested at the environmental extremes of -40°C and $+70^{\circ}\text{C}$. The test shall be conducted for two complete cycles. Attenuation measurements shall be made after pre-conditioning and again at the end of the last high and low temperature points of the test.

7.20.2 Acceptance Criteria

For single-mode fibers, the increase in attenuation shall be ≤ 0.40 dB/km at 1550 nm. For multimode fibers, the increase in attenuation shall be ≤ 0.60 dB/km at 1300 nm.

7.21 Cable Cyclic Flexing Test

The cyclic flexing test for cable measures the ability of a cable to withstand flexure through a 180° arc for a prescribed number of cycles. It is used to evaluate the ability of the cable to survive repeated flexing as may be encountered during installation efforts.

7.21.1 Test Procedure

Test in accordance with the requirements of FOTP-104, using Procedures I and IV. The mandrel diameter used shall be $\leq 20X$ the cable outer diameter. The test shall be repeated for a total of 25 cycles. Measure or monitor the transmitted optical power or attenuation of selected fibers.

7.21.2 Acceptance Criteria

The presence of visible cracks, splits, tears, or other openings on either the inner or outer surface of the jacket constitutes a failure. There shall be no visible cracks in the armor or shielding greater than 5 mm in length. For single-mode fibers, the residual increase in attenuation shall be ≤ 0.40 dB at 1550 nm. For multimode fibers, the residual increase in attenuation shall be ≤ 0.60 dB at 1300 nm.

7.22 Cable Impact Test

The impact test measures the optical transmission and mechanical changes that may occur when the cable, at room temperature, is subjected to an impact perpendicular to its surface. It is used to evaluate the ability of the cable to survive impact forces as may be encountered during installation efforts, or during shipping or handling.

7.22.1 Test Procedure

Test in accordance with the requirements of FOTP-25. The impact energy shall be at least 2.94 Nm.

7.22.2 Acceptance Criteria

The presence of visible cracks, splits, tears, or other openings on the outer surface of the jacket constitutes a failure. The presence of broken fibers within the specimen constitutes a failure. For single-mode fibers, the residual increase in attenuation shall be ≤ 0.40 dB at 1550 nm. For multimode fibers, the residual increase in attenuation shall be ≤ 0.60 dB at 1300 nm.

7.23 Cable Cold Impact Test – Fire Resistant Cable Only

The cold impact test measures the ability of the fire-retardant cable jacket to withstand an impact at cold temperatures, without compromising the subsequent protection afforded to the cable core.

7.23.1 Test Procedure

Test in accordance with the requirements of FOTP-25. The impact energy for indoor/outdoor (fire-resistant) cables shall be at least 2.94 Nm. The cable shall be conditioned for four hours at -10°C . The specimens shall be tested inside of the environmental chamber.

7.23.2 Acceptance Criteria

The presence of visible cracks on either the inner or outer surface of the jacket constitutes a failure. No optical measurements are required.

7.24 Cable Tensile Loading, Bending and Fiber Strain Test

The optical fiber cable tensile loading and bending test measures the optical transmission and mechanical changes that may occur due to tensile loading combined with bending of the cable, primarily as a result of installation related forces. This test evaluates both the strength members and the susceptibility of the fibers to stress due to such forces. The construction and dimensions of the cable, especially the strength member(s), affect the cable's resistance to performance degradation or damage due to tensile loading and bending from installation related forces.

For aerial self-supporting cables the requirements of this test do not generally apply as the most restrictive forces are due to post-installation loading of the cable resulting from local environmental conditions (e.g., ice and wind). For cables intended for aerial self-supporting applications, users should refer to Annex C for additional considerations.

For the purposes of this Standard, the requirements of this Section do not apply to aerial self-supporting cables, unless otherwise agreed upon between the manufacturer and user.

7.24.1 Test Procedure

Tensile loading and bending measurements and data reporting shall be as required by FOTP-33. The fiber strain test may be performed separately, or as part of the tensile loading and bending test. Fiber strain measurements and data reporting shall be made as required by FOTP-38.

A universal mandrel with a maximum diameter of 300 mm (12.0 in) should be used. Other sizes are allowed, but shall not exceed 30 times the cable diameter in accordance with FOTP-33. Test Conditions are as follows:

- Test Condition I is prior to the application of the load.
- Test Condition II is with the cable under the tensile loading:

<u>Installation Method</u>	<u>Rated Installation Load</u>
Pulled into Duct	1335 N (300 lbf)
Direct Buried/Trenched/Blown into Duct	440 N (100 lbf)
Aerial Self-Supporting	As agreed upon between manufacturer and user

Residual Load

30 % of the rated installation load for all except aerial self-supporting

- Test Condition III is with the load removed.

For cables not having a circular cross-section, bending requirements are to be determined using the thickness (minor axis) as the cable diameter and bending in the direction of the preferential bend.

The steps of the test procedure shall be as follows:

1. Measure the optical power transmission at Test Condition I. This is the baseline measurement from which all attenuation increases are calculated.
2. Tension the cable to the Rated Installation Load (Test Condition II) and hold for 60 minutes.
3. Measure the fiber strain per FOTP-38, while the cable is held at the Rated Installation Load.
4. Reduce the tension to the Residual Load level (Test Condition II) and hold for 10 minutes.
5. Measure the optical power transmission per FOTP-33 while the cable is held at the Residual Load.

6. Measure the fiber strain per FOTP-38, while the cable is held at the Residual Load.
7. Remove the load (Test Condition III), and allow the cable to relax for 5 minutes.
8. Measure the optical power transmission per FOTP-33.

7.24.2 Acceptance Criteria

The axial fiber strain shall be $\leq 60\%$ of the fiber proof level while the cable is under the Rated Installation Load.

The axial fiber strain shall be $\leq 20\%$ of the fiber proof level while the cable is under the Residual Load.

The increase in attenuation at the Residual Load shall be ≤ 0.40 dB at 1550 nm for single-mode fibers, and ≤ 0.60 dB at 1300 nm for multimode fibers.

The increase in attenuation after load removal shall be ≤ 0.40 dB at 1550 nm for single-mode fibers, and ≤ 0.60 dB at 1300 nm for multimode fibers.

7.25 Cable Compressive Loading Test

The compressive loading test measures the optical transmission and mechanical changes that may occur when the cable is subjected to compressive loading perpendicular to the axis of the cable. This test evaluates the ability of the cable construction to isolate the optical fibers from external compressive forces. The construction and dimensions of the cables affect the resistance of the cable to performance degradation due to compressive loading. Specified forces are normalized to a unit length of cable (i.e., N/cm or lbf/in).

7.25.1 Test Procedure

The compressive loading test measurements and data reporting shall be as required by FOTP-41. The load to be applied shall be 100 N/cm (57 lbf/in) at a rate of 2.5 mm (0.1 in) per minute and maintained for a period of 1 minute. The load shall then be decreased to 50 N/cm (29 lbf/in).

Alternately, it is acceptable to remove the 100 N/cm (57 lbf/in) entirely and apply the 50 N/cm (29 lbf/in) load within 5 minutes at a rate of 2.5 mm (0.1 in) per minute.

The 50 N/cm (29 lbf/in) load shall be maintained for a period of 10 minutes.

Attenuation measurements shall be performed before release of the 50 N (29 lbf/in) load.

7.25.2 Acceptance Criteria

For single-mode fibers, the increase in attenuation shall be ≤ 0.40 dB at 1550 nm. For multimode fibers, the increase in attenuation shall be ≤ 0.60 dB at 1300 nm.

7.26 Cable Twist Test

The cable twist test evaluates the optical transmission and mechanical changes that may occur in a cable due to twisting. The cable construction and the manner of cable manufacturing may affect the cable performance degradation due to such twisting.

7.26.1 Test Procedure

Cable twist test measurements and data reporting shall be as required by FOTP-85. The length of the cable sample under test shall be no more than 2.0 m (6.5 ft). The test shall be repeated for 10 cycles.

7.26.2 Acceptance Criteria

The cable shall maintain its integrity after completion of the test. The jacket shall not crack or split, when observed with 5X magnification.

For single-mode fibers, the increase in attenuation shall be ≤ 0.40 dB at 1550 nm. For multimode fibers, the residual increase in attenuation shall be ≤ 0.60 dB at 1300 nm.

7.27 Cable Sheath Adherence Test

The cable sheath adherence test measures the resistance of the cable sheath components (armor and the overlaying jacket) to separation, one from another, by measuring the force required to pull the cable core and metallic covering out of the jacket.

7.27.1 Test Procedure

Cable sheath adherence measurements and data reporting shall be as required by ASTM D 4565 at 23 ± 5 °C.

The requirement is specified in force/unit circumference, and the circumference measurement shall be made over the metallic tape.

7.27.2 Acceptance Criteria

The minimum sheath adherence shall be 14 N/mm (80 lbf/in) for armored cables.

7.28 Cable Water Penetration Test

The water penetration test measures the degree to which water may penetrate a specimen of cable that is subjected to a specified water head for a specified period of time.

7.28.1 Test Procedure

Water penetration measurements and data reporting shall be as required by FOTP-82, using tap water. Sodium Fluorescein dyes may be added at the option of the testing laboratory. Testing shall be conducted for a period of 1 hour.

7.28.2 Acceptance Criteria

There shall be no evidence of fluid leaking from the exposed end of the cable sample under test.

7.29 Cable Fire Resistance

Completed fire-resistant cables shall be tested and listed in accordance with the requirements specified by the body whose approval or listing is to be obtained. See Paragraph 1.9.

7.30 Cable Lightning Damage Susceptibility Test (Optional)

There is no lightning rating requirement for optical drop cables. Products covered by this standard may be subject to the lightning damage susceptibility test as agreed upon between manufacturer and user. In these cases the lightning rating category shall be determined per FOTP-181.

7.31 Shield Heating Test (Optional)

When required by the Detail Specification, the shield, armoring, or other metallic covering shall be capable of carrying a current of 60 A rms for 15 minutes, without opening or creating a risk of fire.

7.31.1 Test Procedure

The test specimen shall be at least one meter in length. The 60 Hz source for the test shall have adequate voltage to drive 60 A current in the test specimen. Connections of the source to the ends of the shield shall have negligible resistances in order to minimize local heating. A single layer of cheesecloth shall be draped over the specimen and a current of 60 A rms maintained through the shield for 15 minutes.

7.31.2 Acceptance Criteria

A risk of fire is indicated by the ignition or charring of the cheesecloth. Charring shall be considered to have occurred if the structural integrity of the fibers of the cheesecloth has been destroyed. Discoloration or singeing of the fibers of the cheesecloth shall not be considered charring.

PART 8

FINISHED CABLE OPTICAL PERFORMANCE REQUIREMENTS

8.1 Optical Performance

The optical performance values in Tables 8-1 through 8-3 are routinely specified in the Detail Specification. When these values are not specified, a finished cable shall conform to the minimum performance requirements of Tables 8-1 through 8-3.

Table 8-1
Attenuation Coefficient Performance Requirements

Fiber Type	Attenuation in dB/km Maximum
Multimode (50/125 μ m)	3.5/1.5 @ 850/1300 nm
Multimode (62.5/125 μ m)	3.5/1.5 @ 850/1300 nm
Single-mode (Class IVa)	1.0/1.0 @ 1310/1550 nm

Table 8-2
Multimode Bandwidth Coefficient Performance Requirements

Source Conditions	Minimum Modal Bandwidth (MHz•km)		
	50/125		62.5/125
	492AAAB	492AAAC	
OFL			
850 nm	500	1500	160
1300 nm	500	500	500
EMB			
850 nm	NA	2000	NA

Table 8-3
Point Discontinuity Acceptance Criteria

Fiber Type	Attenuation in dB Maximum
Multimode (all)	0.2/0.2 @ 850/1300 nm
Single-mode (Class IVa)	0.1/0.1 @ 1310/1550 nm

8.2 Attenuation Coefficient

Attenuation coefficient (sometimes referred to as attenuation rate), $\alpha(\lambda)$, is defined as the diminution of optical power at wavelength λ , and is usually expressed as dB per unit length. The equation is:

$$\alpha(\lambda) = \left[\frac{-10}{L} \right] \log_{10} \left[\frac{P_B(\lambda)}{P_A(\lambda)} \right]$$

Where: $P_B(\lambda)$ is the output power of the test fiber at wavelength λ at point B, $P_A(\lambda)$ is the input power to the test fiber at wavelength λ at point A, and L is the length of fiber between point A and point B.

8.2.1 Test Procedure

Unless otherwise agreed upon, optical attenuation measurement methods shall be as shown in Table 8-4.

Table 8-4
Optical Attenuation Measurement Methods

Fibers	Measurement Method	Light Launch
Multimode, Graded Index only	FOTP-46 (Steady-State, Attenuation)	FOTP-50
Multimode, Graded Index only	FOTP-61 (OTDR measurement)	FOTP-50
Single-mode only, Dispersion Unshifted	FOTP-78 (Cutback measurement)	FOTP-78
Single-mode only, Dispersion Unshifted	FOTP-61 (OTDR measurement)	FOTP-61

8.2.2 Acceptance Criteria

The maximum attenuation performance values at specific wavelengths shall be as specified in Table 8-1.

8.3 Multimode Optical Bandwidth

The modal bandwidth of a multimode fiber may be specified with overfilled launch (OFL) or restricted mode launch (RML) conditions, however RML bandwidths are not requirements of this standard. RML is addressed further in Annex B. It may also be derived from other surrogate means as an effective modal bandwidth (EMB) such as those specified for laser optimized fibers supporting serial high data rate systems (e.g., 10 Gigabit Ethernet or 10 Gigabit Fibrechannel).

8.3.1 Test Procedure

Modal bandwidth of multimode fibers shall be measured using the test procedures shown in Table 8-5.

Table 8-5
Multimode Optical Bandwidth Measurement Methods

Source Conditions	Test Procedure
OFL	FOTP-204
RML ⁽¹⁾	FOTP-204
EMB	FOTP-220

1) See Annex B for additional information on RML bandwidth.

When the results are reported as pulse spreading per unit length (in ns/km), the method of normalization to unit length shall be reported. Use light launch conditions as required by FOTP-204. Unless otherwise specified use FOTP-57 for guidance on fiber end preparation.

8.3.2 Acceptance Criteria

The bandwidth shall be greater than or equal to the values specified by the Detail Specification or Table 8-2.

8.4 Measurement of Optical Point Discontinuities

A point discontinuity is a localized deviation of the optical fiber loss characteristic. The location and magnitude of such point discontinuities along an optical fiber cable may be determined by appropriate OTDR measurements.

8.4.1 Test Procedure

Point discontinuity measurements shall be as required by FOTP-59.

8.4.2 Acceptance Criteria

The maximum values at specific wavelengths shall be as specified in Table 8-3.

8.5 Cable Cutoff Wavelength Measurement (Single-Mode Fibers)

The cutoff wavelength of an optical fiber in a cable (λ_{cc}) is the shortest wavelength that will support propagation of only one mode in a cabled fiber. Operation below this wavelength may allow multimode propagation, which can substantially decrease the information carrying capacity.

8.5.1 Test Procedure

FOTP-80 shall be used. The method for reporting test results shall be in accordance with that described in the FOTP. A mapping function relating fiber cutoff wavelength as measured in accordance with FOTP-80, and cabled cutoff wavelength may be used to comply with the requirements of this clause. The manufacturer shall demonstrate the validity of the mapping function.

8.5.2 Acceptance Criteria

The maximum cutoff wavelength for optical cable shall be ≤ 1260 nm for Class IVa and other single-mode fibers specified to operate in the 1310 nm and 1550 nm regions.

PART 9

REFERENCES

<u>Specification and Issue Date</u>	<u>Title</u>
ANSI/ASQ 9000-1 - 94	Quality Management Systems Requirements
ASTM D 1693 - 01	Standard Test Method for Environmental Stress-Cracking of Ethylene Plastics
ASTM D 4565 - 99	Standard Test Methods for Physical and Environmental Performance Properties of Insulations and Jackets for Telecommunications Wire and Cable
ASTM D 4566 - 98	Standard Test Methods for Electrical Performance Properties of Insulations and Jackets for Telecommunications Wire and Cable
ASTM E 29 - 99	Standard Practice for Using Significant Digits in Test Data to Determine Conformance with Specifications
ASTM G 155 - 00	Standard Practice for Operating Xenon Arc Light Apparatus for Exposure of Non-Metallic Materials
C22.2 No. 232	Canadian Standards Association (CSA)
ICEA P-57-653-95	Guide for Implementation of Metric Units in ICEA Publications
ICEA S-104-696-01	Indoor - Outdoor Optical Fiber Cable
ICEA S-83-596-01	Fiber Optic Premises Distribution Cable
ANSI/ICEA S-84-608-94	Telecommunications Cable Filled, Polyolefin Insulated, Copper Conductor - Technical Requirements
ANSI/ICEA S-87-640-99	ICEA Standard For Optical Fiber Outside Plant Communications Cable
ANSI/IEEE 100-2000	Dictionary of Electrical and Electronic Terms
ANSI/IEEE C2-2002	National Electrical Safety Code

<u>Specification and Issue Date</u>	<u>Title</u>
IEEE 812-84	Definitions of Terms Relating to Fiber Optics
IEC 60793-2	Optical Fibres - Part 2: Product Specifications
ISO 9001 - 2000	Quality Management Systems Requirements
NFPA - 70	National Electrical Code ®
NMX-J-237-1997-NYCE	Telecommunications-Cables-Optical Fiber Cables for Premises Applications.
TIA/EIA-440-A - 89	Fiber Optic Terminology
TIA/EIA-455-B- 98 ⁽¹⁾	Standard Test Procedures for Fiber Optic Fibers, Cables, Transducers, Sensors, Connecting and Terminating Devices, and Other Fiber Optic Components
TIA/EIA-455-3A - 89	Procedure to Measure Temperature Cycling Effects on Optical Fibers, Optical Cable, and Other Passive Fiber Optic Components
TIA/EIA-455-13A - 96	Visual and Mechanical Inspection of Fiber Optic Components, Devices, and Assemblies
TIA/EIA-455-25C - 02	Repeated Impact Testing of Fiber Optic Cable and Cable Assemblies
EIA-455-33A - 88	Fiber Optic Cable Tensile Loading and Bending Test
TIA/EIA-455-37A - 93	Low or High Temperature Bend Test for Fiber Optic Cable
TIA/EIA-455-38 - 95	Measurement of Fiber Strain in Cables Under Tensile Load
TIA/EIA-455-41A - 93	Compressive Loading Resistance of Fiber Optic Cables
TIA/EIA-455-46A - 90	Spectral Attenuation Measurement for Long-length, Graded- Index Optical Fibers

Note (1): TIA/EIA-455 series documents are commonly known as FOTPs (e.g. TIA/EIA-455-25B is equivalent to FOTP-25).

**Specification
and Issue Date**

Title

TIA/EIA-455-50B - 98	Light Launch Conditions for Long-Length Graded Index Optical Fiber Spectral Attenuation Measurements
TIA/EIA-455-57B - 96	Preparation and Examination of Optical Fiber Endface for Testing Purposes
TIA/EIA-455-59A - 00	Measurement of Fiber Point Defects Using an OTDR
TIA/EIA-455-61A-00	Measurement of Fiber or Cable Attenuation Using an OTDR
TIA/EIA-455-78B - 02	Spectral-Attenuation Cutback Measurement for Single-Mode Optical Fibers
TIA/EIA-455-80B - 98	Measuring Cutoff Wavelength of Uncabled Single-Mode Fiber by Transmitted Power
TIA/EIA-455-81B - 00	Compound Flow (Drip) Test for Filled Fiber Optic Cable
TIA/EIA-455-82B - 92	Fluid Penetration Test for Fluid-Blocked Fiber Optic Cable
TIA/EIA-455-85A - 92	Fiber Optic Cable Twist Test
TIA/EIA-455-86-99	Fiber Optic Cable Jacket Shrinkage
TIA/EIA-455-89B - 98	Fiber Optic Cable Jacket Elongation and Tensile Strength
TIA/EIA-455-98A - 90	Fiber Optic Cable External Freezing Test
TIA/EIA-455-104A - 93	Fiber Optic Cable Cyclic Flexing Test
TIA/EIA-455-123 - 00	Measurement of Optical Fiber Ribbon Dimensions
TIA/EIA-455-131 - 97	Measurement of Optical Fiber Ribbon Residual Twist
TIA/EIA-455-141 - 99	Twist Test for Optical Fiber Ribbon
TIA/EIA-455-173 - 90	Coating Geometry Measurement For Optical Fiber Side View Method
TIA/EIA-455-178A - 96	Measurements of Strip Force for Mechanically Removing Coatings from Optical Fibers
TIA/EIA-455-181 - 93	Lightning Damage Susceptibility Test For Fiber Optic Cables With Metallic Components

<u>Specification and Issue Date</u>	<u>Title</u>
TIA/EIA-455-203 - 2000	FOTP-203 Launched Power Distribution Measurement Procedure for Graded-Index Multimode Fiber Transmitters
TIA/EIA-455-204 - 2000	FOTP-204 Measurement of Bandwidth on Multimode Fiber
TIA/EIA-455-220 - 2001	Differential Mode Delay Measurement of Multimode Fiber in the Time Domain
TIA/EIA-4920000-B-97	Generic Specification for Optical Fibers
TIA/EIA-492A000-A-97	Sectional Specification for Class Ia Graded-Index Multimode Optical Fibers
TIA/EIA-492AA00-A-98	Blank Detail Specification for Class Ia Graded-Index Multimode Optical Fibers
TIA/EIA-492AAAA-A-98	Detail Specification for 62.5 μm Core Diameter/125 μm Cladding Diameter Class Ia Graded-Index Multimode Optical Fibers
TIA/EIA-492AAAB-98	Detail Specification for 50 μm Core Diameter/125 μm Cladding Diameter Class Ia Graded-Index Multimode Optical Fibers
TIA/EIA-492AAAC-02	Detail specification for 850-nm laser-optimized, 50- μm core diameter/125- μm cladding diameter class Ia graded-index multimode optical fibers
TIA/EIA-492C000-98	Sectional Specification for Class IVa Dispersion-Unshifted Single-Mode Optical Fibers
TIA/EIA-492CA00-98	Blank Detail Specification for Class IVa Dispersion-Unshifted Single-Mode Optical Fibers
TIA/EIA-492CAAA-98	Detail Specification for Class IVa Dispersion-Unshifted Single-Mode Optical Fibers
TIA/EIA-492CAAB-00	Detail Specification for Class IVa Dispersion-Unshifted Single-Mode Optical Fibers with Low Water Peak.
TIA/EIA-598B - 2001	Optical Fiber Cable Color Coding
TL-9000 R3.0 - 2001	Quality Management System – Requirements Handbook

ANNEX A

Informative

ORDERING INFORMATION

A.1 If a user wishes to utilize this Standard for procurement purposes, the following minimum information should be included in the purchase document:

1. The quantity of each item desired, in meters or feet.
2. The name of the item (Outdoor or Indoor/Outdoor Optical Fiber Drop Cable).
3. The identifying reference number for the standard (ICEA S-110-717).
4. Cable construction desired. This may be defined by use of a manufacturer cable code or catalog reference, or by specifying the following:
 - a. The intended application (duct, direct buried, aerial lashed, aerial self-supporting, etc.). See Annex C for specific additional considerations for specifying aerial self-supporting cables.
 - b. The general type of cable desired (Dielectric, Hybrid or Metallic).
 - c. The specific type of cable desired (filled or dry core, loose tube or ribbon, etc.).
 - d. The number, type, class, subclass and size (diameter) of the optical fibers desired.
 - e. Special construction requirements (shielding, armoring, strength members, jacketing materials, fire-resistance, etc.) that apply.
5. Any special identification (color codes, print statements, etc.) requirements that apply.
6. Any special product application requirements that could impact the installation or life of the item (e.g., environmental loading conditions for aerial installations, duct size limitations, etc.)
7. Any special quality requirements that apply (see Paragraph 1.8), including any special test or reporting requirements.
8. Any other deviations from the requirements of this Standard that apply.

ANNEX B

Informative

MULTIMODE RML BANDWIDTH INFORMATION

Modal bandwidth measurements on type A1b¹ fibers (62.5/125 μm – 200 MHz·km at 850nm) obtained by a restricted mode launch at 850 nm have been shown to correlate with the effective modal bandwidth produced by 850-nm laser transmitters only when such transmitters meet certain launch conditions. More specifically, for type A1b fibers, an 850-nm RML bandwidth ≥ 385 MHz·km provides a minimum 385 MHz·km effective modal bandwidth for sources meeting the following three launch conditions.

1. Nominal operating wavelength = 850 nm
2. Encircled flux ≤ 25 % at 4.5- μm radius
3. Encircled flux ≥ 75 % at 15- μm radius

Encircled flux is measured in accordance with TIA/EIA-455-203.

1) Type A1b fibers are described in IEC 60793-2.

ANNEX C

Informative

AERIAL DROP CABLE CONSIDERATIONS

C.1 Introduction

When planning for the aerial installation of optical fiber drop cables, there are several important factors to consider with respect to the design, specification, installation and performance of the optical plant. Although optical drop cables used in aerial applications typically span short distances and run for only one or two spans, they are subject to the same harsh environmental conditions as the larger and more robust optical fiber cables used in distribution type applications. As with any aerial installation, factors such as cable design (size, fiber count, tensile properties, etc.), span distance, installation method, installation tension, and environmental loading conditions need to be addressed.

Ultimately, the factors above are key to ensuring that a particular limiting condition, or conditions, are not exceeded. The primary limiting conditions for a typical aerial installation are the allowable cable sag, the tensile rating of the cable or messenger (if used), or attachment hardware, and the allowable fiber strain or attenuation at maximum environmental loading.

This informative Annex contains general information on the considerations and limiting conditions listed above. Users are encouraged to contact the cable manufacturer to ensure that they, the users, specify products that meet the needs of each particular application.

C.2 Aerial Plant Considerations

C.2.1 Cable Design

The most critical factor to consider in the design, specification, and operation of any physical plant installation is the type of cable to be used. For aerial installations, the cable must be water-blocked and UV-resistant for use outdoors, it must be specifically designed for the intended application, and it must be properly installed. Placing a cable design in an aerial application for which it is not intended, especially in a self-supporting configuration, can significantly reduce the lifetime of the installed plant and can create a safety hazard.

In addition, factors such as cable weight and diameter, the number and type of strength members, fiber count, etc., determine the ability of a cable to span a specific distance,

under given environmental loading conditions, and still operate properly. In general; the larger the cable diameter, the more the environmental loading will increase from wind pressure and ice accumulation. However, as long as the cable is specified, manufactured, and installed properly, these factors can be adequately accounted for.

C.2.2 Span Distance

As the span distance increases (i.e., the distance between the pole and the customer premises building), the tensile force placed on the aerial cable or messenger wire at the attachment points increases. This effect is magnified under severe environmental conditions such as strong winds or heavy ice. In certain applications, users may find it necessary to go to a more robust design, such as a self-supporting distribution cable, in order to achieve the required span distance capability. This Standard does not specify self-supporting span distance capabilities for the cables it covers because of the complexities involved in determining such an attribute. Potential users should contact the cable manufacturer to ensure that the cable requested is appropriate for the application, prior to placing the order.

C.2.3 Installation Method

The primary aerial installation methods are self-supporting, in which the cable tensile strength members are integral to the cable itself, or lashed, in which the cable is bound to a pre-strung messenger wire. Self-supporting cables can further be broken down into all-dielectric and metallic designs, the latter typically employing a steel messenger wire in a "Figure 8" configuration.

In self-supporting applications, it is more important to know the span capability under various environmental conditions, but somewhat less important to know the actual tensile load capability of the cable. Users are encouraged to work with the manufacturer to ensure the cable requested meets the requirements of the application. In no case should other cables (power, coaxial, non self-supporting optical cables, etc.) be lashed to a self-supporting optical cable, unless specifically approved by the manufacturer.

In aerial lashed applications, almost any cable designed for outdoor use (e.g., duct cable) can be utilized by attaching it to a pre-strung messenger wire. In these cases, the messenger wire carries the load so that the forces placed on the optical cable are minimized. However, in such installations, it is possible to exceed the safe load rating of the messenger wire or cable depending on the size and type of messenger wire used, and on the number and sizes of the cables attached to it. For this reason it is important to contact the cable manufacturer for guidance to ensure a successful installation in an aerial lashed application.

C.2.4 Installation Tension

Installation tension is the tension placed on the cable during the initial installation to achieve a certain sag value under expected worst-case environmental loading conditions. However, installation tension also affects the tensile forces placed on the cable under those same conditions, and will therefore affect the span distance capability. In general, a higher installation tension will reduce the cable sag, but place the cable closer to its design tensile strength limit, thereby limiting achievable span distances. Users should check with the cable manufacturer, as well as governing codes, for guidance on cable sag and installation tension requirements.

C.2.5 Environmental Loading

Environmental loading is generally defined as the additional loading placed on an aerial cable due to the presence of wind and/or ice. These loads can be shown as force vectors, and occur in both the vertical plane (i.e., ice loading) and the horizontal plane (i.e., wind loading). The vector product resulting from the two indicates the total load placed on the cable due to the environment. Environmental loading is an important consideration because it must be accounted for to ensure that the integrity of the cable plant is maintained over the design lifetime, under all expected environmental conditions.

The National Electrical Safety Code® contains information on the environmental conditions that affect cable loading. The three predominant categories for the United States are designated as heavy, medium, and light. However, even taking such information into account does not guarantee that the plant will not be adversely affected by severe conditions falling outside of expected normal. Users should work with manufacturers to ensure they reasonably account for expected conditions, as well as for any extreme conditions that can be reasonably predicted. For example, installations at or near certain portions of the various coastlines may need to account for the severe wind loads produced by large ocean-borne storms, such as hurricanes or Nor'easters.

C.2.6 Other

There may be other considerations that need to be accounted for in regards to a particular installation, such as installation temperature. Users are encouraged to contact the cable manufacturer to determine what additional considerations may exist.

C.3 Limiting Conditions

The following potentially limiting conditions should be addressed to ensure the proper design, specification, installation, and operation of the installed cable plant, and the performance of the aerial drop cables.

C.3.1 Cable Sag

Sag defines the vertical displacement the cable will experience under various conditions. It is impacted by temporal and environmental factors such as cable creep and worst-case environmental loading. Cable sag is an important consideration in installations spanning roads, navigable waterways, train tracks, or other hazards. Sag is usually expressed in terms of the vertical displacement distance, or as a percentage of the span length. Users should contact the Local Authority Having Jurisdiction for clearance requirements over applicable hazards.

C.3.2 Rated Tensile Loads

These are the maximum safe operating loads for the various system components and must be observed to ensure long-term system integrity. The system tensile load limits of interest are as follows:

1. The manufacturer's declared Maximum Rated Cable Load (MRCL)
2. Messenger tensile strength (if used)
3. Attachment hardware tensile load capability (clamps, brackets, etc.)

Exceeding the design capabilities of one or more of these components could reduce the operating lifetime of the cable plant, and can result in damage to the cable or other structures due to the cable sagging or falling. Refer to Paragraph C.4 for tensile testing requirements.

C.3.2.1 Installation Hardware

Some special consideration must be given to the compatibility of the attachment hardware with the cable being installed. Under higher tensions (i.e. at full environmental loading), it is necessary to ensure that the attachment hardware used does not damage the cable resulting in the loss of jacket integrity or long-term reliability, excessive attenuation increases, or fiber breaks. With improperly specified, installed or maintained hardware, such damage can occur well below the tensile capability of the cable itself.

Because the types of attachment hardware from the various manufacturers are many and diverse, they are not addressed in detail in this Standard. Potential users should contact the cable manufacturer to ensure that the attachment hardware selected for the application is appropriate for the cable design, prior to purchasing the hardware or installing the cable.

C.3.3 Fiber Strain

In some cases an installation can meet the tensile requirements for the cable, messenger, or other hardware, but exceed fiber strain requirements, thereby potentially affecting the long-term reliability of the installed plant. The cable manufacturer should be consulted with the specifics of the installation to ensure that the allowable fiber strain values will not be exceeded.

C.4 Static Tensile Testing of Aerial Self-Supporting Cables

The Static Tensile Test determines the ability of aerial self-supporting cable to withstand the prevailing environmental conditions in the geographic area of the installation. The National Electrical Safety Code[®] contains general information of the environmental conditions that affect cable loading. The three predominant categories for the United States are designated as heavy, medium, and light. Refer to Paragraph C.2.5 on Environmental loading.

A dynamic tensile test is not applicable for the cable types addressed by this standard.

C.4.1 Test Procedure

When agreed to by the manufacturer and user, a static tensile test shall be conducted in accordance with EIA/TIA FOTP-33, with exceptions as noted in Paragraph C.4.1.2. The fiber strain test must be performed as part of the static tensile test. Fiber strain measurements and data reporting shall be made as required by FOTP-38.

C.4.1.1 Test Conditions

1. Test Condition I is prior to the application of the load.
2. Test Condition II is with the cable under the tensile loading:
3. Test Condition III is with the load removed.

The Maximum Rated Cable Load (MRCL) and the maximum added axial fiber strain are to be provided by the cable manufacturer for the specific cable type being tested. The MRCL and the maximum added fiber strain shall not be exceeded throughout the test.

C.4.1.2 Exceptions to FOTP-33

1. The use of sheaves is not required. If used, sheaves shall meet the requirements of Paragraph 7.24.1.
2. Prior to the start of the test, test sample ends shall be secured to prevent the ends of the optical fiber from moving relative to the cable ends.
3. A minimum of 25 m (82 ft) of the test sample shall be subjected to the applied tensile load.

C.4.1.3 Test Steps

1. Measure the optical power transmission at Test Condition I.
2. Tension the cable to the MRCL (Test Condition II). Apply the load in increments recommended by the cable manufacturer. Record the following:
 - a. Cable load and strain
 - b. Optical power transmission
 - c. Added axial fiber strain.
3. Remove the load (Test Condition III) and allow the cable to relax for 5 minutes. Record the optical power transmission

C.4.2 Acceptance Criteria

The axial fiber strain at MRCL shall be ≤ 60 % of the fiber proof level.

The increase in attenuation at MRCL, and after load removal, shall be ≤ 0.40 dB at 1550 nm for single-mode fibers, and ≤ 0.60 dB at 1300 nm for multimode fibers.

ANNEX D

Informative

FUSING COORDINATION TEST

D.1 Fusing Coordination:

This test simulates the conditions under which a composite cable must not fuse, or otherwise cause a fire hazard, in the presence of abnormal AC currents.

D.1.1 Test Procedure

Using the electrical test setup shown in Figure D-1, the probable generation of a fire hazard shall be determined by draping a single layer of cheese cloth over the wire test specimen at both of the conductor ends not confined within the jacket. The cheese cloth required for the test is single ply bleached cotton 14-15 yd/lbf (2.9-3.1 m/N) having a 32 X 28 inch count which is 32 threads in one direction and 28 threads in the other direction per square inch (13 threads by 11 threads per square cm). Igniting or charring of the cheesecloth or emission of flame or molten metal indicates risk of fire hazard. Charring shall be considered to have occurred if there is any damage to the structural integrity of the fibers of the cheesecloth when examined under normal or corrected to normal vision. Discoloration or singeing of the cheesecloth shall not be considered charring.

D.1.2 Acceptance Criteria

A single conductor within a completed cable shall conduct the following currents for the indicated durations in Table D-1. No fire hazard shall develop during the intervals as indicated by the condition of the cheesecloth. The conductors shall be electrically continuous after testing.

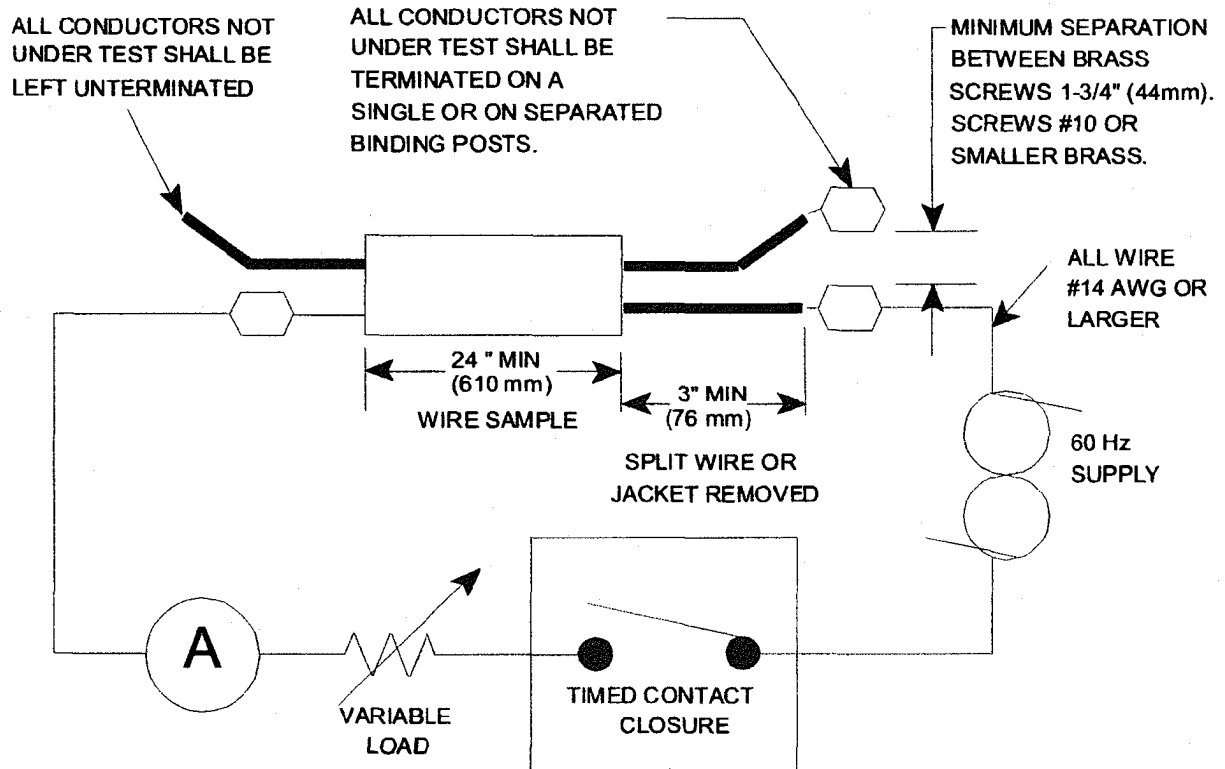
Table D-1
Test Currents and Durations

Test Current (Amperes)	30	35	40	60	80	100
Current Duration ⁽¹⁾ (Seconds)	30	14	10	3.5	1.8	1.0

Note (1): The duration of each current is based upon protection of the wire by a fuse link consisting of either a 24 AWG stub cable or a 0.028 inch diameter Copper-Steel 40 % conductivity block wire.

D-1

Figure D-1
Fusing Coordination Test Configuration



ANNEX E

Informative

ICEA TELECOMMUNICATIONS CABLE STANDARDS

These standards were developed by the Insulated Cable Engineers Association, Inc. (ICEA) or jointly with the Telecommunications Wire & Cable Standards, Technical Advisory Committee (TWCS TAC) where indicated with an asterisk (*).

<u>NUMBER</u>	<u>DESCRIPTION</u>
ICEA P-47-434-1965	Pressurization Characteristics, PE Communication Cable
ANSI/ICEA S-56-434-1983	Polyolefin Insulated Communications Cables For Outdoor Use, Reaffirmed October 18, 1991
ANSI/ICEA S-77-528-1983	Outside Plant Communications Cables, Specifying Metric Wire Sizes (Rev. 1990), Reaffirmed April 27, 1990
ANSI/ICEA S-80-576-2002	Communications Wire & Cable For Premises Wiring
ICEA S-83-596-2001	Fiber Optic Premises Distribution Cable
ANSI/ICEA S-84-608-2002 (*)	Telecommunications Cable, Filled Polyolefin Insulated Copper Conductor
ANSI/ICEA S-85-625-2002 (*)	Aircore, Polyolefin Insulated, Copper Conductor Telecommunications Cable
ANSI/ICEA S-88-626-1993	Telephone Cordage and Cord Sets
ANSI/ICEA S-86-634-1996 (*)	Buried Distribution & Service Wire, Filled Polyolefin Insulated, Copper Conductor
ANSI/ICEA S-87-640-1999	Fiber Optic Outside Plant Communications Cable
ANSI/ICEA S-89-648-2000 (*)	Telecommunications Aerial Service Wire
ANSI/ICEA S-90-661-2002 (*)	Category 3, 5, & 5e Individually Unshielded Twisted Pair Indoor Cables (With or Without an Overall Shield) for Use in General Purpose and LAN Communication Wiring Systems

<u>NUMBER</u>	<u>DESCRIPTION</u>
ANSI/ICEA S-91-674-1997 (*)	Coaxial & Coaxial/Twisted Pair Composite Buried Service Wires
ANSI/ICEA S-92-675-1997 (*)	Coaxial & Coaxial/Twisted Pair Composite Aerial Service Wires
ANSI/ICEA S-100-685-1997 (*)	Thermoplastic Insulated and Jacketed Telecommunications Station Wire for Indoor/Outdoor Use
ANSI/ICEA S-98-688-1997 (*)	Broadband Twisted Pair, Telecommunications Cable Aircore, Polyolefin Insulated Copper Conductors
ANSI/ICEA S-99-689-1997 (*)	Broadband Twisted Pair Telecommunications Cable Filled, Polyolefin Insulated Copper Conductors
ICEA S-104-696-2001 (*)	Indoor-Outdoor Optical Fiber Cable
ANSI/ICEA S-101-699-2001 (*)	Category 3, Individually Unshielded Twisted Pair Indoor Cable for Use in General Purpose Non-LAN Telecommunications Wiring Systems, Technical Requirements

